

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

GODDARD, David, John
Harrison Goddard Foote
1 Stockport Road
Marple
Stockport SK6 6BD
ROYAUME-UNI

Date of mailing (day/month/year) 26 May 2000 (26.05.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P20963WO1	
International application No. PCT/GB99/04277	International filing date (day/month/year) 16 December 1999 (16.12.99)

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address COKER, Timothy, Martin Screen Technology Ltd. Unit D5 Button End Harston Cambridge CB2 5NX United Kingdom	State of Nationality GB	State of Residence GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address COKER, Timothy, Martin 4 Brewery Court South Road Oundel Peterborough PE8 4DZ United Kingdom	State of Nationality GB	State of Residence GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input checked="" type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer I. Britel Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
Box PCT
Washington, D.C. 20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 11 August 2000 (11.08.00)	
International application No. PCT/GB99/04277	Applicant's or agent's file reference P20963WO1
International filing date (day/month/year) 16 December 1999 (16.12.99)	Priority date (day/month/year) 19 December 1998 (19.12.98)
Applicant COKER, Timothy, Martin et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
11 July 2000 (11.07.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p style="text-align: center;">The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer</p> <p style="text-align: center; font-weight: bold;">Pascal Piriou</p> <p>Telephone No.: (41-22) 338.83.38</p>
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PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

GODDARD, David, John
Harrison Goddard Foote
11C Compstall Road
Marple Bridge
Stockport SK6 5HH
ROYAUME-UNI

Date of mailing (day/month/year) 06 November 2000 (06.11.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P20963WO1	
International application No. PCT/GB99/04277	International filing date (day/month/year) 16 December 1999 (16.12.99)

1. The following indications appeared on record concerning:		
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input checked="" type="checkbox"/> the agent
<input type="checkbox"/> the common representative		
Name and Address GODDARD, David, John Harrison Goddard Foote 1 Stockport Road Marple Stockport SK6 6BD United Kingdom	State of Nationality	State of Residence
	Telephone No. 0161 427 7005	
	Facsimile No. 0161 427 7026	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input type="checkbox"/> the name	<input checked="" type="checkbox"/> the address
<input type="checkbox"/> the nationality		
<input type="checkbox"/> the residence		
Name and Address GODDARD, David, John Harrison Goddard Foote 11C Compstall Road Marple Bridge Stockport SK6 5HH United Kingdom	State of Nationality	State of Residence
	Telephone No. 0161 427 7005	
	Facsimile No. 0161 427 7026	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer</p> <p>Christine Carrié</p> <p>Telephone No.: (41-22) 338.83.38</p>
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INTERNATIONAL COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P20963W01	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 99/ 04277	International filing date (day/month/year) 16/12/1999	(Earliest) Priority Date (day/month/year) 19/12/1998
Applicant THE SECRETARY OF STATE FOR DEFENCE et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

FAST READOUT OF MULTIPLE DIGITAL BIT PLANES FOR DISPLAY OF GREYSCALE IMAGES

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☒ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

P B 99/04277

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G09G3/36 G09G3/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP 0 762 375 A (TEXAS INSTRUMENTS INC.) 12 March 1997 (1997-03-12) see abstract column 1, line 16 -column 3, line 14 column 3, line 45 - line 55; figures 1-3B column 4, line 41 - line 51 column 5, line 6 -column 6, line 11 --- -/--</p>	1,5

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 May 2000

Date of mailing of the international search report

09/05/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Corsi, F

INTERNATIONAL SEARCH REPORT

International Application No.

P GB 99/04277

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 774 745 A (MATSUSHITA ELECTRONICS CO.) 21 May 1997 (1997-05-21) see Abstract column 3, line 14 -column 5, line 14; figures 36-40 column 6, line 34 - line 57; figure 44 column 8, line 9 - line 19 column 12, line 9 -column 13, line 14; figures 1-3 column 25, line 12 -column 27, line 13; figures 26-30 ---	1
A	EP 0 884 717 A (MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD.) 16 December 1998 (1998-12-16) see abstract page 2, line 10 - line 43 page 3, line 18 -page 4, line 45; figures 1-3,6 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

P B 99/04277

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 762375	A	12-03-1997	CA 2184129 A	01-03-1997
			CN 1170881 A	21-01-1998
			JP 9211346 A	15-08-1997
			SG 63662 A	30-03-1999
			US 5969710 A	19-10-1999
EP 774745	A	21-05-1997	JP 9198006 A	31-07-1997
			US 5940142 A	17-08-1999
EP 884717	A	16-12-1998	US 5841413 A	24-11-1998
			CN 1212564 A	31-03-1999
			JP 11119725 A	30-04-1999

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FAST READOUT OF MULTIPLE DIGITAL BIT PLANES FOR DISPLAY OF GREYSCALE IMAGES

- The present invention relates to a method of operating a display or spatial light modulator in which the instantaneous intensity distribution afforded by the display or modulator is binary in nature but which is altered in a manner such that the time averaged distribution effectively has, or appears to have, multiple intensity levels. For display purposes, this means that the alteration must be sufficiently fast for averaging to occur at the eye, preferably avoiding any flicker. This requirement may or may not apply for other purposes.
- 10 The invention can be used in conjunction with any spatial light modulator capable of producing a binary image, including those comprising an array of individually addressable cells or pixels, and those where the binary image is produced by scanning of a modulated light beam, for example. The term "binary spatial light modulator" used herein is intended to encompass all such devices, whether they are used for
- 15 display or other purposes, for example information recordal, and variable components (for example lenses, filters and diffraction gratings) in optical systems. The term is intended to cover passive modulators where an existing light beam is affected by the modulator, and also those which act as light sources, for example arrays of light emitters, and electroluminescent devices.
- 20 The term "image" as used herein is used to denote any spatially varied light distribution, normally, but not necessarily, of light intensity, and its production or resulting distribution will be referred to by the term "display".
- 25 Furthermore, although the term "grey scale" is used herein as denoting a multi-level distribution, it should be made clear that the term is used in relation to any colour, including white. In addition, although the methods, arrays, backplanes, circuitry etc. of the invention and its embodiment are described in relation to a single colour (monochrome images), including white, it is envisaged that variable colour images or

displays etc. will be produced in manners known per se, such as by spatially subdividing a single array into different colour pixels, superimposing displays from differently coloured monochrome arrays for example by projection, or temporal multiplexing, for example sequential projection of red green and blue images.

- 5 Temporally varying binary modulation to achieve a multiple intensity effect is known, and can be effected by the use of multiple bit planes. In such a scheme, an array of digitised values, of amplitudes corresponding to the grey scale values allocated to the pixels of the array, is decomposed into a multiplicity of bit planes. This multiple bit plane technique may be used with any binary spatial light modulator
10 as defined above.

It is possible to decompose a n-level grey scale image into a plurality of binary image planes of equal duration, with a corresponding plurality of bitplanes of equal duration. However, in a preferred form, known as a weighted bit plane technique, the durations of the bit planes are weighted, each bitplane being representative of one level
15 (exponent) of the digitisation. This reduces the number of bit planes which need to be stored to synthesise an image, and can reduce addressing requirements somewhat.

Although in certain cases, it would be possible to use digital bases other than 2, this complicates matters insofar as each bit plane is not binary and thus is not so easily stored. Furthermore, each location of such a bit plane would then have more than one
20 non-zero value, and the variation in non-zero values across the bit plane would need to be taken into account for the durations of operation of each pixel (possibly by further decomposing the non-binary plane to two or more binary planes). The discussion below will be limited to binary weighting, but the principles set out in such a context are believed to be sufficient to enable the skilled person to extrapolate to
25 other exponential bases if required or desired.

Where the digitisation is binary, so that each bit plane is an array of digital 1s and 0s, it is then only necessary to display each bit plane for a total period proportional to its

binary weighting to provide a time averaged image equivalent to the digitised grey scale image.

- Where possible, it is convenient to display each binary bit plane once for the total duration necessary to contribute to the grey scale image, but it is also possible to
- 5 display one or more of the bit planes a plurality of times, not necessarily sequentially, provided that the total time spent in displaying each bitplane, relative to the total time spent in displaying all the bitplanes, is proportional to its binary weighting.

- The different bit planes for a grey scale image can be stored as sequential binary strings in a computer, and will be read out one at a time in any desired order after
- 10 which they can be discarded unless the image needs to be repeated. It is computationally easiest to read out the bit planes in the order in which they have been stored, since then the only address which needs to be stored is the starting address of the first stored bit planes, all bit planes then being read out one at a time simply by clocking out a predetermined number of data bits in sequence for each bit planes.

- 15 It might be possible immediately to replace bit planes that have been read by the bit planes for a succeeding image, particularly where the bit planes are being produced in real time. However, under other circumstances this could be difficult, and the set of bit planes for a successive image will then normally be stored elsewhere. In certain cases it would be possible to provide storage for just two bit planes one of which is
- 20 written while the other is being read, and vice versa.

It would also be possible to control the reading and/or writing processes so as to convert the image standards as desired, for example from line sequential to interlaced.

- As or after each bit plane is read from memory, it is then written, e.g. using the single pass scheme described below, and viewed over a period corresponding to its
- 25 weighting so that the eye synthesises the intended grey scale image. The single pass scheme is preferred insofar as it merely over-writes the preceding bitplane without the need for a second pass, the associated front electrode switching and blanking pulses.

The avoidance of lost time between successive valid images enables continuous illumination and the easier provision of bitplanes of an accurately weighted duration.

5 In such a scheme, each pixel is subjected to a series of voltage pulses according to the point in the grey scale it represents (as in the number representing the grey scale level, and usually but not necessarily in that order). There are more points in the grey scale than there are applications of voltages, due to the weighting employed, which is advantageous since it reduces the time spent actually driving the array. Each applied voltage may be of the same or opposed polarity compared to the preceding voltage, and the same number of voltage pulses, equal to the number of bit planes (ignoring
10 polarity), is applied to each pixel to synthesise the image.

For example, in a 64 level grey scale with binary weighting, there will be 6 bit planes with relative durations of $2^n t$ where n ranges from 0 to 5, and each pixel can be represented by a corresponding 6 digit binary number.

15 However, double pass schemes below could alternatively be adapted for use in multiple or weighted bit plane schemes.

To achieve dc balance, it would be possible to produce each binary bit plane by any binary imaging method which itself produces dc balance - for example by starting from a blank image, writing, viewing and erasing the binary image by selective energisation (+V) and driven blanking (-V) of selected pixels only.

20 However, in most or all of such schemes, the actual duration of the binary image is not directly proportional to the time allocated thereto, for example because of intervening blanking steps, etc., leading to a degree of distortion in the binary nature of the bitplane periods, and hence the perceived grey scale values. While this could be compensated for if desired, it represents an additional complication.

25

Recently there has been developed a novel spatial light modulator in the form of a smectic liquid crystal layer disposed between an active semiconductor backplane and a common front electrode. It was developed in response to a requirement for a fast and, if possible, inexpensive, spatial light modulator comprising a relatively large number of pixels (320 x 240 up to 640 x 480) with potential application not only as a display device, but also for other forms of optical processing such as correlation and holographic switching. Depending on the manner in which it is driven, and the value of the applied voltage, the modulator may be driven at a line rate of at least 10MHz and a frame rate of up to 15 to 20kHz, requiring a data input of around 1 to 1.5 Gpixel per second. Typically, while the pixel address time is around 100 nanoseconds, the pixel will actually take around 1 to 5 microseconds to switch between optical states; and while overall frame writing time is of the order of 24 microseconds, the frame to frame writing period is around 80 microseconds.

This spatial light modulator can be driven according to single pass schemes, in which the front electrode is placed at a potential of $V/2$ relative to the backplane pixels, which are switched to zero volts or V volts.

Alternatively it can be driven according to double pass schemes in which in one pass the front electrode is placed at zero volts and selected pixels are turned ON by switching pixel elements of the backplane array to V volts, and in the other pass the front electrode is placed at V volts and selected pixels are turned OFF by switching elements of the array to zero volts. For pixels which are not in the process of being switched the elements of the backplane follow the voltage of the front electrode. To maintain the same potential difference therebetween, the voltage at all backplane pixel elements of the array is simultaneously switched as the voltage on the front electrode is changed between zero and V volts.

Our copending International Patent Applications (ref: P20957WO, priority GB9827952.4; P20958WO and P20958WO1, both priority GB9827965.6; P20959WO, priority GB9827900.3; P20960WO, priority GB9827901.1; P20961WO, priority GB9827964.9; P20962WO, priority GB9827945.8); and P20963WO, priority

GB 9827944.1) relate to other inventive aspects associated with this spatial light modulator, including the single and double pass schemes referred to in the preceding paragraph.

5 The aforesaid spatial light modulator is ideally suited to the use of the bitplane technique mentioned above. However, the present invention is not limited to liquid crystal modulators, but can be applied to any spatial light modulator as referred to above.

One problem which arises, particularly when operating liquid crystal display and modulators, is that of maintaining a dc balance at individual pixels. Our copending
10 International Patent Application (ref: P20963WO) filed together with this application is directed to a weighted bit plane technique as described above in which at least some of the bit planes are modified, and relates to a method of grey scale imaging using a weighted bit plane technique, in which an n-digit binary number represents the intended grey level of each pixel location in an array of binary pixels, wherein at
15 least one said binary number has an unequal number of 1s and 0s, said method comprising the step of altering the number to a closely adjacent value such as to reduce the inequality of 1s and 0s. That method has particular but not exclusive relevance to the production of effective grey scale intensity distributions for display purposes, where the effective duration of the binary images (length and/or number of
20 repeats) is such that temporal integration thereof, for example by a viewer, gives the grey scale image. It finds particular but not exclusive application to liquid crystal spatial light modulators, and enables dc balance to be obtained or at least more closely approximated at each pixel.

The weighted bitplane method as operated therein requires that relaxation of the
25 liquid crystal pixels is negligible over the duration of the longest bitplane, and this is not always possible. In such a case, the bitplanes can be refreshed during the bitplane period(s), but at the expense of dc balance.

Basically, a refresh step comprises repeating the application of the same voltage as was applied at the start of the bitplane so as to restore the switched state of the pixel. It may even be that the n th power binary weighted bitplane needs to be refreshed $(2^n - 1)$ times subsequent to the first writing so that a 2^n greyscale will involve 2^n frame
5 writes of binary images when the refresh writing stages are included.

In a refresh scheme, bitplanes are read out more than once, depending on the duration thereof. Thus it is not possible to discard the bitplane until it has undergone its final reading. Furthermore, if each bitplane is repeatedly read for the requisite number of times before proceeding to the next bitplane, it is necessary to store the starting
10 address of the two bitplanes.

For example, taking a simple case of three bitplanes A, B and C, of relative durations $4t$, $2t$ and t respectively, it would be possible to read these out in the order AAAABBC. However, this necessitates storing the start addresses of each of the bitplanes, apart from plane C which is read only once, in order that the correct place
15 for the refresh readout may be reached.

In addition, and perhaps more importantly, there are cases where it is necessary to rewrite the entire grey scale image before proceeding to a new image, where display times are long or relaxation is fast for example. In such a case it is necessary not only to store the start address of the bitplane next to be used, but also the start address of
20 the first bit plane of the entire sequence, until that image information is no longer required.

An improved method of readout in such cases makes it possible to avoid the storage of a plurality of start addresses. At the high speeds involved in reading out the images when using the spatial light modulator of the preferred embodiment, this
25 apparently minor step can be computationally significant and advantageous.

According to the present invention a plurality of the highest order bitplanes, or all the bitplanes, are stored as binary strings in sequential locations in a memory, in

decreasing order of intended duration (weighting), a predetermined number of read passes are made from the set of stored bitplanes equal to the number of weighted bitplanes, each pass commencing with the highest order bitplane and continuing along the stored bitplanes in sequence, the lengths of the sequences being selected and varied such that at the end of the predetermined number of read passes each bitplane has been read out a plurality of times proportional to or equal to its duration (weighting). Where the plurality does not include the lower order bitplane(s), these will be read out once, for duration(s) less than the lowest order bitplane of the plurality. This can be done at any time, including a period or periods within the reading out of the plurality, but is preferably performed before or after the entire plurality has been read.

Thus in a method according to the present invention the triple bitplane image exemplified above will be read out with read passes ABC (once), AB (once), and A (twice), which when combined can give an overall order, for example, of ABCABAA, or ABCAAAB or ABAAABC as desired. Only the start address needs to be stored since each read pass commences at the same place, and continues to an address determined by counters.

While some grey scale and refresh schemes automatically provide dc balance, a further option for schemes which do not do this is to allow dc imbalance to accumulate, for example while writing images and then allowing them to relax, calculating the imbalance (e.g. in an accompanying computer simulation), and then applying local dc voltages to the pixels of a magnitude and duration such as to provide zero average dc.

It should be understood that there have been references above to a liquid crystal cell incorporating an addressable array, the methods of the invention may be used in relation to any binary spatial light modulator. Where the imaging device is a liquid crystal device, prolongation of the binary images used to synthesise the grey scale image may be achieved in known manner by the application of an ac field between successive binary images.

CLAIMS

1. A method of signal processing for greyscale imaging in which at least a plurality of the highest weighted bitplanes corresponding to a greyscale image are stored as binary strings in sequential locations in a memory, in decreasing order of
5 intended duration (weighting), a number of read passes equal to the number of weighted bitplanes are made from the set of stored bitplanes, each pass commencing with the highest order bitplanes and continuing along the stored bitplanes in sequence, the lengths of the sequences being varied and selected such that at the end of the said number of read passes each bit plane has been read out a plurality of times
10 proportional to or equal to its duration (weighting).
2. A method according to claim 1 wherein said plurality comprises all the bitplanes.
3. A method according to claim 1 wherein there is at least one additional lower order bitplane which is read out once, for a duration less than the duration of the
15 lowest order bitplane of said plurality.
4. A method according to any preceding claim wherein the said number of read passes is repeated.
5. A method according to any preceding claim when used to address a spatial light modulator in the form of a liquid crystal display.
- 20 6. A method according to any preceding claim wherein a small ac potential difference is applied to pixels of the array in periods when images are not being written.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/04277

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G09G3/36 G09G3/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP 0 762 375 A (TEXAS INSTRUMENTS INC.) 12 March 1997 (1997-03-12) see abstract column 1, line 16 -column 3, line 14 column 3, line 45 - line 55; figures 1-3B column 4, line 41 - line 51 column 5, line 6 -column 6, line 11 --- -/--</p>	1,5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 May 2000

Date of mailing of the international search report

09/05/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Corsi, F

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/04277

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP 0 774 745 A (MATSUSHITA ELECTRONICS CO.) 21 May 1997 (1997-05-21) see Abstract column 3, line 14 -column 5, line 14; figures 36-40 column 6, line 34 - line 57; figure 44 column 8, line 9 - line 19 column 12, line 9 -column 13, line 14; figures 1-3 column 25, line 12 -column 27, line 13; figures 26-30</p> <p style="text-align: center;">---</p>	1
A	<p>EP 0 884 717 A (MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD.) 16 December 1998 (1998-12-16) see abstract page 2, line 10 - line 43 page 3, line 18 -page 4, line 45; figures 1-3,6</p> <p style="text-align: center;">-----</p>	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/04277

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 762375	A	12-03-1997	CA 2184129 A	01-03-1997
			CN 1170881 A	21-01-1998
			JP 9211346 A	15-08-1997
			SG 63662 A	30-03-1999
			US 5969710 A	19-10-1999
EP 774745	A	21-05-1997	JP 9198006 A	31-07-1997
			US 5940142 A	17-08-1999
EP 884717	A	16-12-1998	US 5841413 A	24-11-1998
			CN 1212564 A	31-03-1999
			JP 11119725 A	30-04-1999

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P20963WO1	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) FOR FURTHER ACTION	
International application No. PCT/GB99/04277	International filing date (day/month/year) 16/12/1999	Priority date (day/month/year) 19/12/1998
International Patent Classification (IPC) or national classification and IPC G09G3/36		
Applicant THE SECRETARY OF STATE FOR DEFENCE et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 8 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 12 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 11/07/2000	Date of completion of this report 19.03.01
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Wolfrum, G Telephone No. +49 89 2399 2299



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/04277

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).):*

Description, pages:

1-10 as received on 29/01/2001 with letter of 25/01/2001

Claims, No.:

1-10 as received on 29/01/2001 with letter of 25/01/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/04277

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-10
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-10
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-10
	No:	Claims	

2. Citations and explanations

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

1 Re Item I: Basis of the report

The title has been established together with the International Search Report by the International Search Authority (ISA). Amendments of the title do not fall within the competence of the International Preliminary Examination Authority (IPEA).

Furthermore, according to Article 34(2)(b) PCT an amendment must not go beyond the disclosure in the international application **as filed**. Following amendments would appear to contravene Article 34(2)(b) PCT:

1.1 Claim 1:

1.1.1 No basis could be found in the application as filed for the introduction of a "first plurality of binary strings" **and** a "second plurality of said binary strings" as presently defined. The "binary strings" enclosed by both pluralities may be completely different, partially different, identical but different in number or completely identical, i.e. the pluralities may consist of the same strings and the same number of strings. This is considered as adding subject-matter and, therefore, said amendment appears to contravene Article 34(2)(b) PCT.

Thus, in **claim 1** the phrases "a first plurality of", "at least a second plurality of said binary strings associated with the highest weightings are stored" and "of the second plurality" are not acceptable.

1.1.2 No basis could be found in the application as filed for the wording "the numbers of the strings" [line 13] in its literal meaning. Therefore, said amendment appears to contravene Article 34(2)(b) PCT.

1.2 Dependent claims

1.2.1 **Claims 4 to 8** contravene Article 34(2)(b) PCT as a whole, since they are based on said "first" or said "second plurality" (cf. point 1.1.1 above).

1.2.2 **Claim 10:** No basis could be found in the application as filed for replacing "images" by "bit planes" when considering the context of the claim. Therefore, said amendment appears to contravene Article 34(2)(b) PCT.

1.3 Description:

- 1.3.1 No basis could be found in the application as filed that the application is related to EP-A-0762375 (=D1, see below) in the manner described on page 7 in lines 12-16. Thus, the additional phrase "but...to be explained below" of the amended description is not acceptable.
- 1.3.2 Page 7, line 27 to page 9, line 8 of the amended description reflects the amended **claims 1-10**. Some parts and phrases of the amended claims (see points 1.1 and 1.2 above) are found defective with respect to Article 34(2)(b) PCT. Thus, the corresponding parts and phrases of the amended description are also not acceptable.
- 1.3.3 No basis could be found in the application for said "first plurality" **and** said "second plurality" with their meaning as presently understood (cf. point 1.1.1 above). The additional paragraph of page 9 [lines 9-18] is mainly based on said pluralities. Thus, the lines 9-18 on page 9 of the amended description are not acceptable.

As set forth in Rule 70.2 (c) PCT, these amendments are not taken into account in the International Preliminary Examination Report.

2 Re Item VIII: Certain observations according to Article 6 PCT

2.1 Claim 1 does not satisfy the clarity requirements of Article 6 PCT.

- 2.1.1 The meaning of the terms should be clear from the wording of the claims alone. This is not the case for the terms "**multi-level**" and "**weighting**".
- The term "**multi-level**" per se cannot be understood and does not appear to be limiting. However, since each bit plane refers to a "pixelwise **intensity** distribution", each interpretation that does not identify "multi-level" with "multi-intensity" (cf. also **claim 2**) would appear to induce a contradiction. Therefore, the term "multi-level" is obscure.
 - It appears that it is tried to define the term "**weighting**" in an "indirect" manner since the weighting is proportional to the number of times a certain bit plane has been read out in a

"succession of read cycles" (see last three lines of amended **claim 1**). However, this definition is not sufficient for two reasons:

- a) Firstly, said definition is based on the phrase "at the end of said succession of read cycles". However, the subject-matter of **claim 1** does neither define said "end" nor any starting point. It appears that an essential "link" (=feature) between the "signal defining a pixellated [...] image" and the "**succession** of read cycles" is missing.
- b) Secondly, it appears that a further essential "link" (=feature) is missing between the "weighting" of the bit planes and the "signal defining a pixellated [...] image" which is defined by said bit planes: The read out of **one** bit plane (a so-called "binary string") must be connected to the provision of said signal (which appears to control each pixel of a display **for a certain duration**) such that the **number of times** such a bit plane has been read out is proportional to said "weighting". Consequently, said "weighting" must be proportional to an **overall duration** each pixel of said display is controlled by said signal during a complete "**succession** of read cycles". The apparently necessary definition of a complete succession would appear to require the definition of the starting point and the termination point of such a succession. Therefore, the second deficiency b) is apparently connected to the first deficiency a).

In other words, a) and b) reveal a lack of definition of the term "**succession**", which appears not sufficiently functionally limited. For example, a skilled person would not be able to decide when a "**succession**" starts and when it terminates.

- 2.1.2 It is not clear which strings are meant when referring to "**the stored strings**" [line 11 and line 12]. This is related to the problem of the "pluralities of binary strings" (cf. point 1.1.1 above).

- 2.2 Some of the dependent claims do not satisfy the clarity requirements of Article 6 PCT

Claim 10: Taking into account point 1.2.2 and 2.1.1 above, it is noted that a person skilled in the art cannot identify periods "when **images** are not being written".

3 Re Item V: Reasoned statement under Article 33 PCT

- 3.1 Reference is made to the following documents:

D1: EP-A-0 762 375 (TEXAS INSTRUMENTS INC.) 12 March 1997 (1997-03-12)

D2: EP-A-0 774 745 (MATSUSHITA ELECTRONICS CO.) 21 May 1997 (1997-05-21)

D3: EP-A-0 884 717 (MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD.) 16 December 1998 (1998-12-16)

- 3.2 The application is directed to a method of image signal processing (as far as understood, cf. item VIII above) wherein a memory stores a plurality of bit planes (so-called "binary strings") which define a pixellated image and wherein each bit plane has a binary weighting which is proportional to the duration in which each pixel of a display is controlled by said bit plane. Said bit planes have been stored in sequential locations of a memory in strictly decreasing order of said weighting.

The technical problem may be regarded as how to achieve a read out of said memory that requires a minimum of additional computation while achieving that the binary weighting of each bit plane is proportional to the (overall) duration each pixel of a display is controlled by said bit plane during a "frame".

None of the available prior art (documents **D1-D3**) either discloses or suggests the method of image signal processing (as far as understood, cf. item VIII above) which includes the step of making a succession of read cycles as recited in the characterising portion of amended independent **claim 1**. Thus, the subject-matter of **claim 1** is considered to meet the requirements of novelty and inventive step (Article 33(2)(3) PCT).

- 3.3 Consequently, the subject-matter of **claims 2-10**, which are dependent on **claim 1**, is also considered to meet the requirements of novelty and inventive step (Article 33(2)(3) PCT) as far as understood (cf. item VIII above) and as far as taken into account (cf. item I above).